

Functionalization of porous surfaces: New potential of laser ablation in liquids used for bio/photo catalytic nanomaterials

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Abstract:

Laser ablation in liquids (LAL) has been developed into a simple and versatile technique producing various colloidal nanoparticles with novel properties and applications (e.g. biodetection, bioactive materials and photocatalysis). One of the typical problems faced in the bio/photo catalytic applications nanoparticles is their instability towards aggregation and the formation of larger particles, which change the catalytic properties and can even lead to inactive materials. A strong effort is therefore devoted to achieving a higher colloidal stability by various stabilizers or by suitable liquid media. However, the stabilizers are usually not environmentally friendly and freely moveable nanocatalysts can enter biogeochemical cycles and become harmful to the environment living organisms.

It is therefore a novel and attractive idea to make use of the adsorption of nanoparticles on rough surfaces to bind these nanoparticles before they agglomerate in the liquid phase. In this simple way, colloidal photo/bio catalytic nanoparticles could adhere on a porous carrier, functionalize its surface. This unexplored potential of LAL we have revealed for laser ablation of FeS in water and ethanol which produces FeS-derived colloidal nanoparticles that adsorb onto immersed porous ceramic substrates and create solar-light photocatalytic surfaces. The laser induced process thus offers an easy and efficient way for the functionalization of porous surfaces by photocatalytic nanoparticles that avoids aggregation in the liquid phase.

Moreover, LAL induced functionalization has been found as perspective technique also for enhancing of bioactivity of titanium porous/textured surfaces. The importance of the synergy between the two disciplines: (i) chemical reactions of bone growth stimulants under LAL conditions and (ii) the functionalization of laser-shaped micro/nanotopography of titanium surface with colloidal particles generated from targets of bone growth stimulants by laser ablation in selected liquids is examined.

The LAL synthesis of bioconductive colloidal particles of CaTiO_3 , MgTiO_3 and CaSi_2 allowing productivity, zeta potential, size and dispersity control through selected irradiation parameters and different liquid medium. The structure and adhesion of the nanosols to titanium surface is assessed by IR, Raman and XP spectroscopy and SEM and TEM analyses. In vitro osseointegration activity of the functionalized surfaces are evaluated by examining the growth of Mesenchymal Stem cells.

Key words:

functionalization, laser ablation in liquids, bioactivity, photocatalysis